Sheet 2
113

Sheet 2 (3), (5c)

Electronic Circuits & Measurements

Feedback

8.1.1

8.1 (1) A -ve FB amplifier has a closed loop gain $A_f = 100$ and an open-loop gain $A = 10^5$. What is the feedback factor β? If a manufacturing error results in a reduction of A to 10^3, what closed loop gain results? What is the % change in A_f corresponding to this factor of 100 reduction in A? (1)

8.2

8.5 (2) For the -ve FB structure, find the loop gain $A\beta$ for which the sensitivity of closed loop gain to open loop gain $[(dA_f/A_f)/(dA/A)]$ is $-20dB$. For what value of $A\beta$ does the sensitivity become $\frac{1}{2}$?

8.13 (3) A particular amplifier has a non-linear transfer ch/t that can be approximated as follows

a) for $|v_I| \le 10mV$ $v_o/v_I = 10^3$

b) for $10mV \le |v_I| \le 50mV$ $v_o/v_I = 10^2$

c) for $|v_I| \ge 50mV$ o/p saturates

If the amplifier is connected in a -ve FB loop, find the FB factor β that reduces the factor of 10 change in gain to only a 10% change. What is the transfer ch/t of the amplifier with FB

8.14 (4) ~~A series~~ Draw the series-shunt FB amplifier. Using $V_s = 100mV$, $V_f = 95mV$ and $V_o = 10V$. What are the corresponding values of A and β?

section 8.3 في الورق

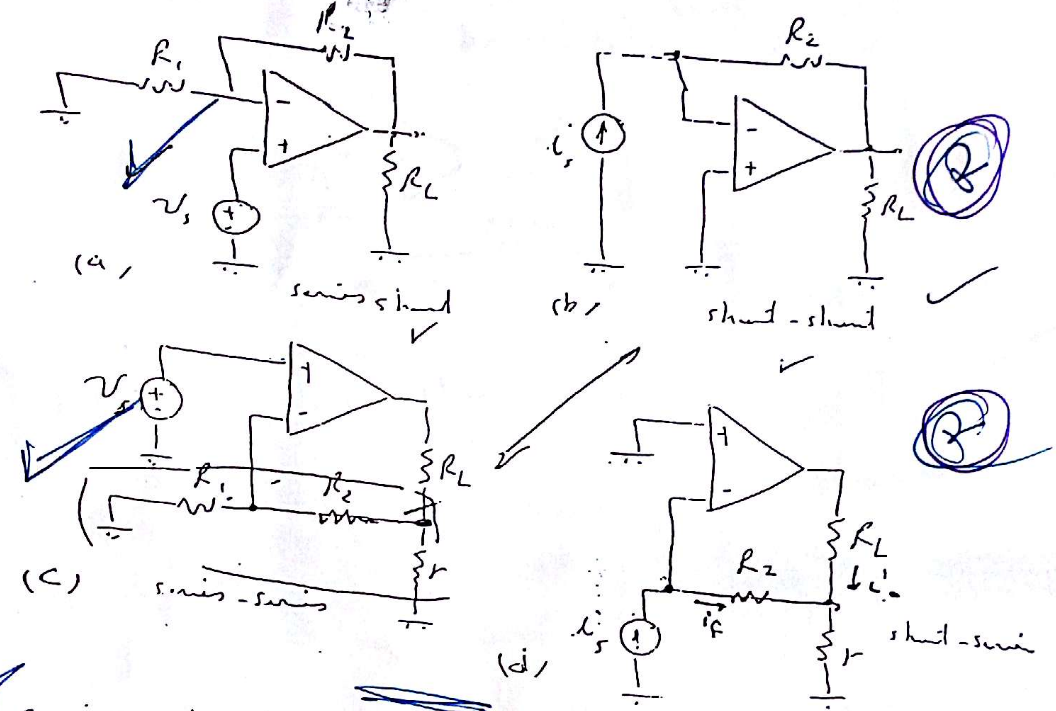
(8-9)

213

(15) For each of [illegible] ...ing op-amp circuits, identify feedback topology [illegible] indicate the output variable being sampled and the F[illegible] signal. Find expression for β and hence find A_f.

25

شرح Feedback لع ١١



8-20

27

(6) A series-shunt FB amplifier employs a basic amplifier with input and output resistances each of 1 kΩ and gain $A = 2000$ V/V. The FB factor $\beta = 0.1$ V/V. Find the gain, A_f, and i/p and o/p resistances R_{if}, R_{of}.

37

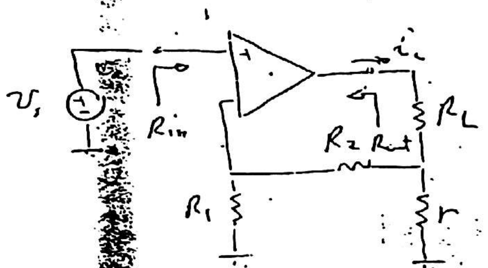
8-30

(7) A series-series FB amplifier employs a transconductance amplifier having $G_m = 100$ mA/V, i/p resistance of 10 kΩ, and o/p resistance of 100 kΩ. The FB network has $\beta = 0.1$ V/mA, an i/p resistance (with port 1 open-circuited) of 100 kΩ, and an i/p resistance (with port 2 open-circuited) of 10 kΩ. The amplifier operates with with a signal source having $R_{sig} = 10$ kΩ, and with $R_L = 10$ kΩ. Find A_f, R_{in}, R_{out}.

2010

8) For the series-series FB amplifier shown, the op-amp is characterized by an open-loop voltage gain μ, $R_{id} = 10k\Omega$, $r_o = 100\Omega$, $R_L = 1k\Omega$. The FB network has R_1, $R_2 = 10k\Omega$, and $r = 100\Omega$. Find $A_f = i_o / v_s$, R_{in}, R_{out} for: a) $\mu = 10^5$ V/V, $R_1 = 100\Omega$

b) $\mu = 10^4$ V/V, $R_1 = \infty$



9) For the amplifier network shown

a) Identify the FB connection type

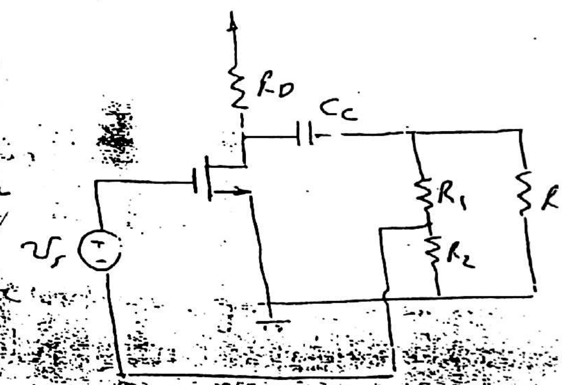
b) Draw the equivalent circuit of the amplifier considering the loading effect of the FB circuit

c) Find expressions, then calculate the numerical values for A, β, A_f, R_{if}, and R_{of}.

given: $R_L = R_D = 10k\Omega$

$g_m = 4$ mA/V, $r_o = 100k\Omega$

$R_1 = 80k\Omega$, $R_2 = 20k\Omega$



Chapter (3)

Feed back.

*what is feedback

المقصود بكلمة Feedback هو اخذ جزء من الخرج ويتم ارجاعه مره اخرى الى الدخل

اذا تم ارجاعه على ال i/p موجب ← -ve feedback

سالب ← +ve feedback

-ve F.B used in amplifier

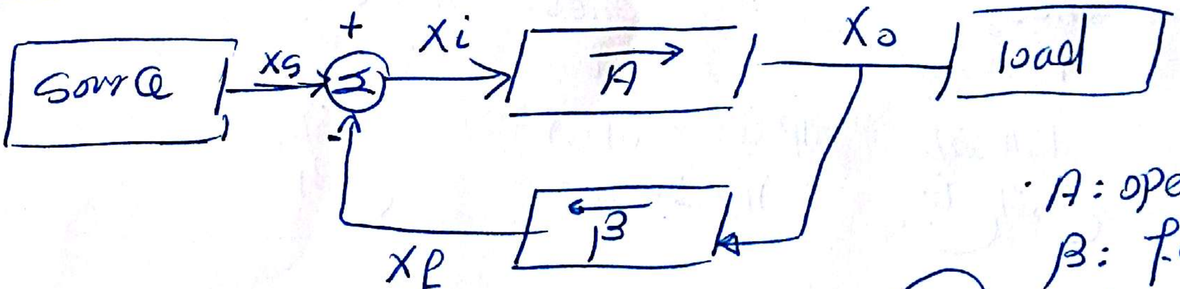
&

+ve F.B used in oscillators

-ve F.B → feedback signal is out of phase of i/p
phase shift = 180°

+ve F.B → " " " " in phase " "
phase shift = 0°

*The General feedback structure



· A: open loop Gain
β: feedback parameter
Aβ: Loop Gain

$$A_f = \frac{A}{1+A\beta} \simeq \frac{A}{A\beta} \simeq \frac{1}{\beta} \qquad A\beta >>> 1$$

* feed back types

There are 4 Types of feed back

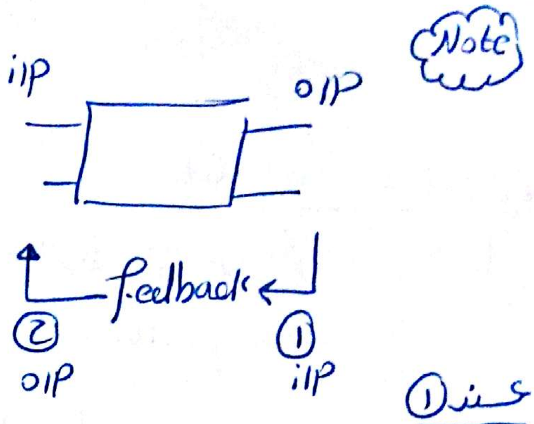
- ↳ series - shunt
- ↳ Series - series
- ↳ shunt - shunt
- ↳ shunt - series

تعود على ال input ↓ ↓ تعود على ال o/p

Series - shunt Feedback

ده معناه series في الـ i/p

ده معناه shunt في الـ o/p



عند ① o/p

عاوز اعمل Feedback لتيار الخرج ∴ توالي هاخد I_o ⟸ لذلك تسمى (Current Feedback ≡ series

عاوز اعمل Feedback لجهد الخرج ∴ توازي هاخد V_o ⟸ لذلك تسمى (voltage Feedback ≡ parrallel

عند ② i/p

عاوز ادخل الـ Feedback على انه

لتيار في الدخل ∴ ادخله توازي في نقطة الدخل ⟸ Called shunt

لجهد في الدخل ∴ ادخله توالي مع الدخل ⟸ Called series

---

series - series

↑ ندخله على أنه جهد في الدخل

↑ ناخد التيار بتاع الخرج

series - shunt

↑ ادخله على انه جهد في الـ i/p

↑ ناخد جهد الخرج

في المحاضرة عامل لكل نوع analysis

اوجاد F ، model ، R_i, R_o, A_F, β

+ R_{11} ، R_{22}

sheet # [3]

[1] -ve F-B , $A = 10^5$ "open loop Gain" $A_f = 100$ Find feed back factor β ??

manu factoring error in $A \rightarrow A_{new} = 10^3$

what is the closed loop Gain

what is the % change in A_f

- $A_f = \frac{A}{1+A\beta} \rightarrow A\beta = \frac{A}{A_f} - 1 = \frac{10^5}{100} - 1 = 999$

$\beta = \frac{999}{10^5} = 9.99 * 10^{-3}$ #

- at $A = 10^3 \rightarrow A_f = \frac{A}{1+A\beta} = \frac{10^3}{1+10^3 \times (9.99 * 10^{-3})}$

$A_f = 90.99$

$\frac{dA_f}{A_f} = \frac{A_{f new} - A_{f old}}{A_{f old}} = \frac{90.99 - 100}{100} \times 100 = -9\ \%$ #

[2] -ve F-B , Find Loop Gain $A\beta$, senstivity of $\frac{\text{Closed loop Gain}}{\text{open loop Gain}} = -20\ dB$

For what value of $A\beta$ does the sensitivity become $\frac{1}{2}$

- $\frac{dA_f}{A_f} \Big/ \frac{dA}{A} = \frac{1}{1+A\beta} =$ senstivity $= -20dB$

$20 \log(1+A\beta)\Big|_{ratio} = 20dB$

$= 1+A\beta = 20dB$

$1+A\beta = 10$

$A\beta = 9$ #

- $\frac{1}{1+A\beta} = \frac{1}{2}$

$1+A\beta = 2$

$A\beta = 1$ #

amplifier has ~~particular~~ non linear c/c
can be approximated as follows
- for small signal → $|V_i| < 10\,mV$ → $\frac{V_o}{V_i} = 10^3$
- for intermediate input signal → $10mV \leq |V_i| \leq 50mV$ → $\frac{V_o}{V_i} = 10^2$
- for large signal → $|V_i| \geq 50mV$ The o/p saturated

∘ The the amplifier connected in -ve F.B → Find β ??

feedback factor
That reduce the ~~factor of~~ gain to only 10% change occuring at ($V_i = 10mV$)

∘ what is the c/c of amplifier with F.B ??

reduce = 10%
remain = 90%

$A_{f2} = 0.9\, A_{f1}$

$$A_f = \frac{A}{1 + A\beta}$$

$$\frac{100}{1 + 100\beta} = 0.9 \frac{10^3}{1 + 10^3\beta} \rightarrow \beta = 0.08$$

$$A_{f1} = \frac{10^3}{1 + 10^3(0.08)} = 12.84 \rightarrow |V_i| \leq 10mV$$

$$A_{f2} = \frac{10^2}{1 + 10^2(0.08)} = 10.1 \rightarrow 10mV \leq |V_i| \leq 50mV$$

then o/p saturated → $|V_i| \geq 50mV$

Now

V_i صغيرة → V_i كبيرة
$A = 10^3$ → $A = 10^2$

لبعد ال Feedback

V_i صغيرة → V_i كبيرة
$A_f = 12.4$ → $A_f = 10$

معدل التغير A_f أقل مع معدل تغير A

6) series - shunt F-B amplifier → i/p & o/p resistors = 1K

gain = A = 2000 V/V

Feedback parameter $\beta = 0.1$ V/V

Find A_f, inp, outp R_{if} R_{of}

$$A_f = \frac{A}{1+A\beta} = \frac{2000}{1+2000\times0.1} \#$$

$$R_{if} = R_i(1+A\beta) = 1K[1+2000\times0.1] \#$$

$$R_{of} = \frac{R_o}{1+A\beta} = \frac{1K}{(1+2000\times0.1)} \#$$

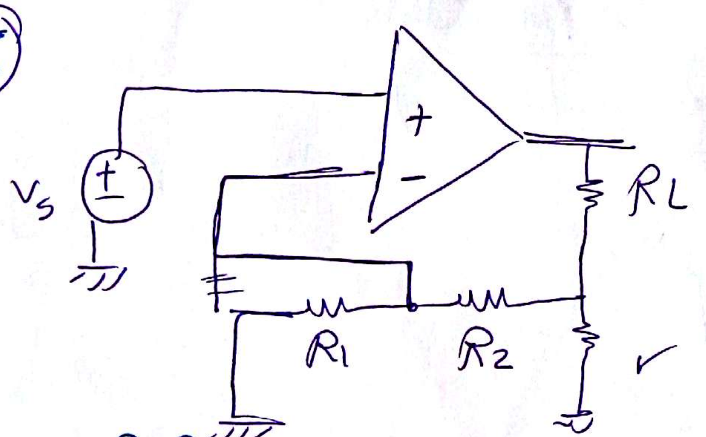
op-amp

5) For each of the following op-amp

↳ identify feedback topology

↳ Find expression for β and then A_f

C



لتحديد النوع

↳ put RL = o.c

if the signal returned to the amplifier i/p by feedback = o

∴ Current feedback

↳ put RL = s.c

--- = o

∴ voltage feedback

o.c

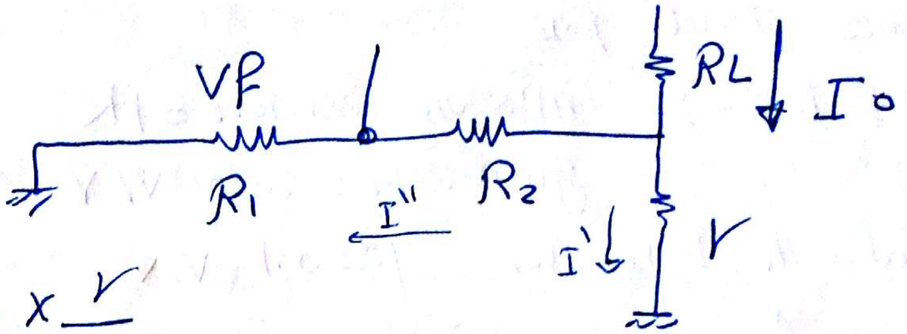
RL ⇒ open circuit

$I_f = 0$ ∴ Current feedback

series ← o/p ∴ في ال

∴ توالي ـ نفس الـ i/p في ال voltage

$\boxed{\text{Series - series}}$ #



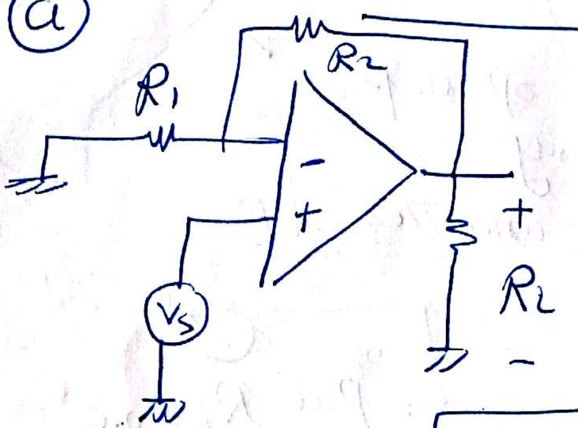
$$I'' = I_o \times \frac{r}{R_1+R_2}$$

$$V_f = I'' R_1 = I_o \frac{r}{R_1+R_2} R_1$$

$$\beta = \frac{V_f}{I_o} = \frac{rR_1}{R_1+R_2} \quad \#$$

$$A_f \simeq \frac{1}{\beta} = \cancel{\pm} \frac{R_1+R_2}{rR_1} = \left[\frac{1}{r} + \frac{R_2}{rR_1}\right] \quad \#$$

(a)

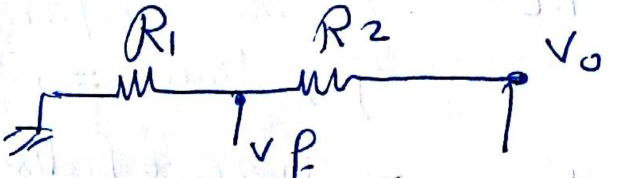


- put $R_L \Rightarrow$ S.C
$V_F = 0$ → = voltage feedb

shunt → o/p

- جمع جهدين - متعاكسين مع الـ → series in i/p

$\boxed{\text{series - shunt}}$



$$V_f = V_o \times \frac{R_1}{R_1+R_2}$$

$$\frac{V_f}{V_o} = \beta = \frac{R_1}{R_1+R_2} \quad \#$$

$$A \simeq \frac{1}{\beta} = \frac{R_1+R_2}{R_1} = 1 + \frac{R_2}{R_1} \quad \#$$

[1]

sec
Feedback

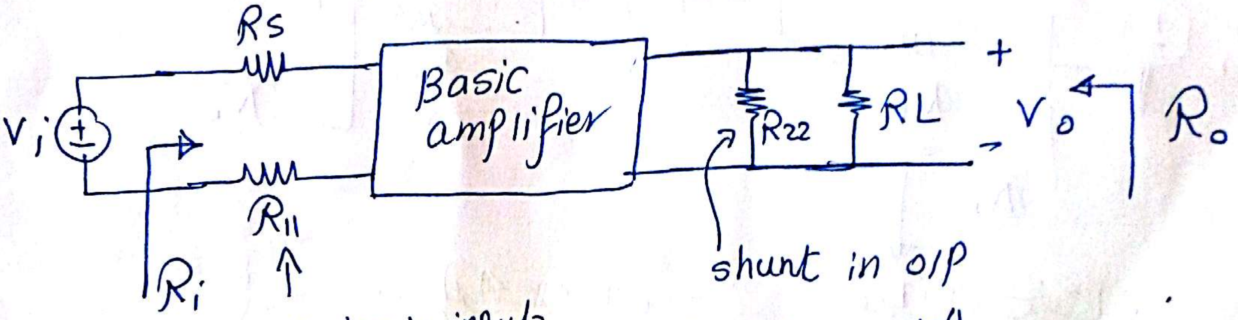
* Series - shunt Feedback

Series ⇓ ده معناه جهد في الدخل

shunt ⇓ ده معناه جهد في الخرج

i/p جهد ⟹ o/p جهد

$A \rightarrow$ voltage gain $A_v = \frac{V_o}{V_i}$



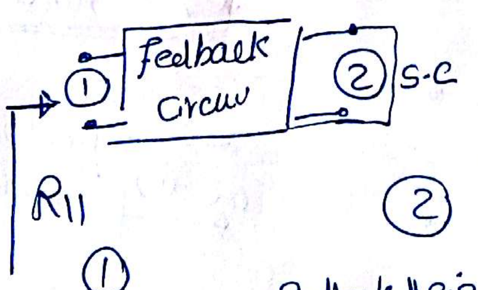
series in input ∴ المقاومة تتحط توالي

shunt in o/p المقاومة تتحط توازي

الاتنين دول نتيجة وجود ال Feedback circuit

	i/p	o/p
V	O-C	S-C
I	S-C	O-C

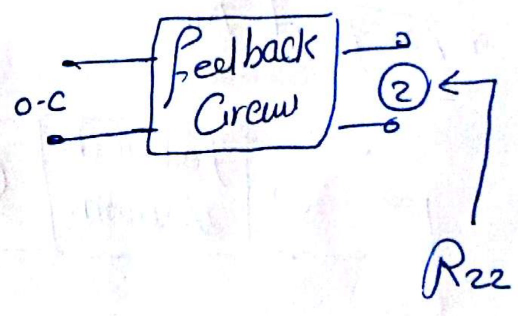
* To find R_{11}



1 دخل ال Feedback هو هو خرج ال amplifier

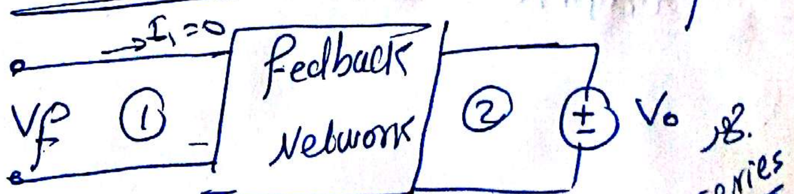
2 خرج ال Feedback هو دخل ال amplifier

* To find R_{22}



* To find β

$$\beta = \frac{V_f}{V_o}$$



o/p amplif
i/p feedback → shunt

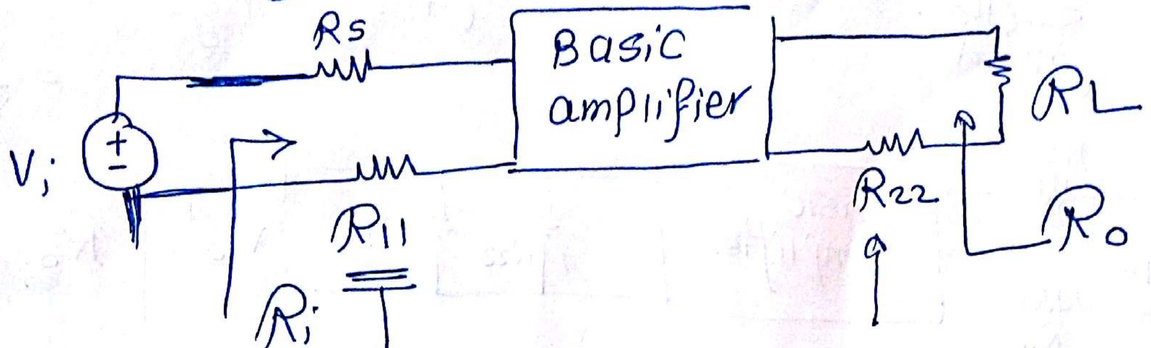
i/p

جهد series

Series - Series Feedback

ده ومعناه جهد في الدخل

ده ومعناه ~~جهد~~ تيار في الخرج



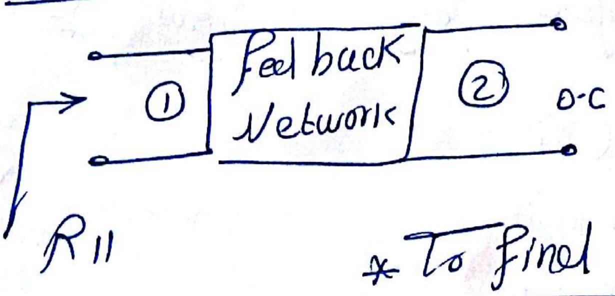
خدنا توالى عشان
i/p series

خدنا توالى عشان
o/p series

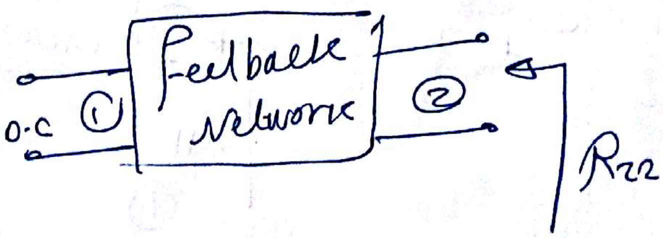
* جهد i/p ⟹ تيار o/p

$$A \equiv \frac{I_o}{V_i} = \text{TransConductance.}$$

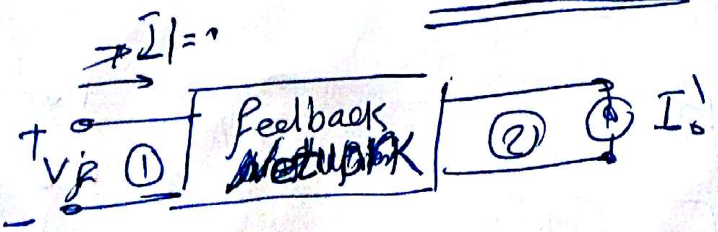
*To find R_{11}



*To find R_{22}



*To find β



$$\beta = \frac{V_f}{I_o}$$

6

* in Series-shunt

ولا؟ R_s — R_i & R_o → input & output impedance of A circuit حلال م

R_{if} & R_{of} → " " " of feedback amplifier including RL & Rs

The acual input and output impedance of feed back amplifier excluding RL & Rs

$$R_{in} = R_{if} - R_s$$

$$R_{out} = \frac{1}{\frac{1}{R_{of}} - \frac{1}{R_L}}$$

* in series-series

$$R_{in} = R_{if} - R_s$$

$$R_{out} = R_{of} - R_L$$

$\boxed{7}$ series-series feedback amplifier employs a trans Conductance

- $G_m = 100\ mV/A$ & i/p Resistance of $10K\Omega$
  o/p " " $100K\Omega$
- feedback Network → $\beta = 0.1\ V/mA$
  and i/p resistance " with port 1 open circuit $= 100K\Omega$
  i/p " " " 2 " " $= 10K\Omega$

$R_{signal\ source} = 10K\Omega$ $R_L = 10K\Omega$

Find A_f & R_{in} & R_{out}

$$A_f = \frac{A}{1+A\beta} = \frac{100\ \frac{mA}{V}}{1 + 100\frac{mA}{V} \times 0.1\ \frac{V}{mA}} =$$

$R_{in} = R_{if} - R_s$ $\quad$ $R_{out} = R_{of} - R_L$

$R_{if} = R_i(1+A\beta)$ $\quad$ $R_{of} = R_o(1+A\beta)$

$R_i = R_s + R_{if} + R_{11}$ $\quad$ $R_o = R_L + R_{of} + R_{22}$

??

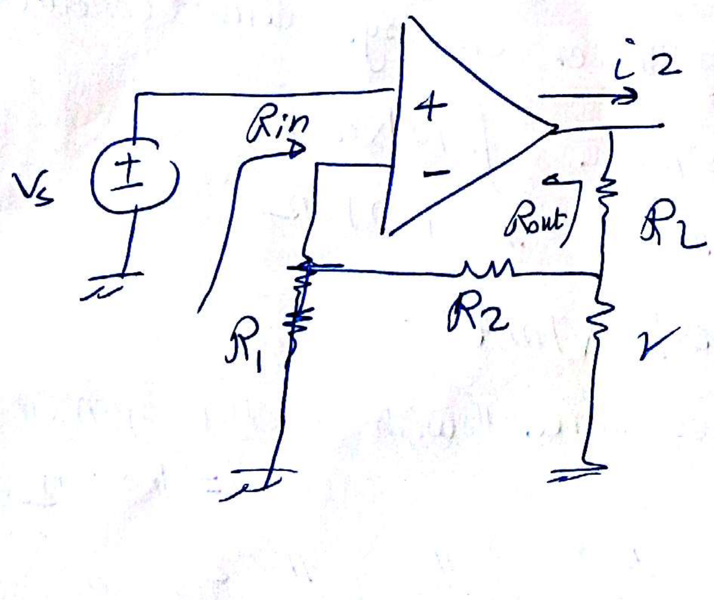
$\boxed{8}$ series - series F.B $\quad$ Find $A_f = \frac{i_o}{V_s}$

Voltage Gain μ $\quad$ R_{in}

$R_{id} = 10K$ $\quad$ $r_o = 10$ $\quad$ R_{out}

a) $\mu = 10^5$ V/V $\quad$ $R_1 = 100\,\Omega$

b) $\mu = 10^4$ V/V $\quad$ $R_1 = \infty$



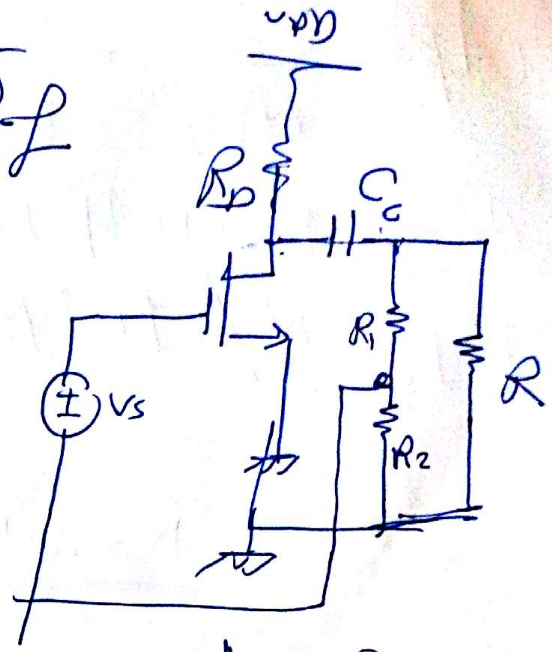
9 a) identify F.B connection type
b) Draw equivalent circuit of amplifier + feedback
c) expression and calculate

$A, \beta, A_f, R_{if}, R_{of}$

$R_L = R_s = 10\,k\Omega$

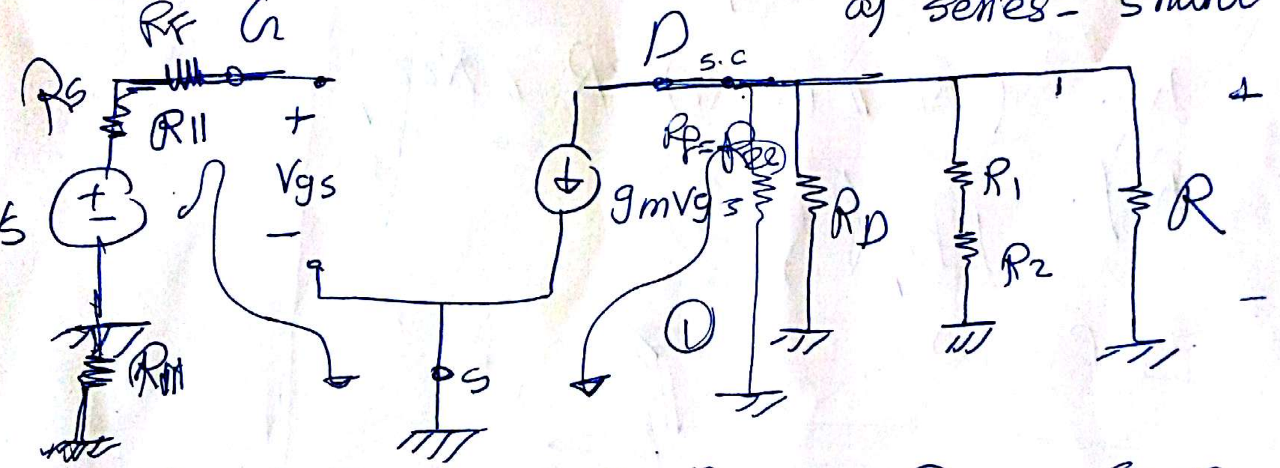
$g_m = 4\,mA/V$ $\quad r_o = 100\,\Omega$

$R_1 = 20\,k\Omega$ $\quad R_2 = 20\,k\Omega$



a) series - shunt

b) ac analysis



i/p → Gate $\quad$ o/p → D $\quad$ Common Source

A_v = voltage gain = $-g_m R_{Drain}$

at K.V.L (1)

$V_o = -(g_m V_{gs}) \times [R_D \parallel (R_1+R_2) \parallel R \parallel R_{22}]$ (1)

R_{11}, R_s اهملهم → ∞ بتساوي

at K.V.L (2)

$V_{in} - V_{gs} = 0 \longrightarrow V_{in} = V_{gs}$ (2)

$A_v = \frac{V_o}{V_{in}} = \frac{-g_m \cancel{V_{gs}} [R_D \parallel (R_1+R_2) \parallel R \parallel R_{22}]}{\cancel{V_{gs}}} = -g_m [\,----\,]$

Scanned by CamScanner

$A = -g_m \left[R_D \,//\, (R_1+R_2) \,//\, R \,//\, R_{22} \right]$

$$A_f = \frac{A}{1+A\beta} = \frac{-g_m \left[R_D \,//\, (R_1+R_2) \,//\, R \right]}{1 + \left(-g_m \left(R_D \,//\, (R_1+R_2) \,//\, R\right)\right)\beta}$$

$R_{if} = R_i (1+A\beta) \longrightarrow R_{in} = R_{if} - R_s$ #

$R_{of} = R_o / (1+A\beta) \longrightarrow R_{out} = \dfrac{1}{\dfrac{1}{R_{of}} - \dfrac{1}{R_L}}$ #

$\Downarrow$

R_o & R_i ايجاد

$R_i = \infty \longrightarrow R_{if} = \infty \longrightarrow R_{in} = \infty$

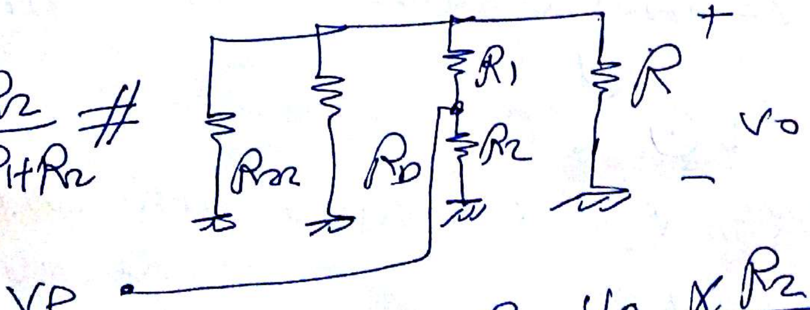
$R_o = \left(R_D \,//\, (R_1+R_2) \,//\, R \,//\, R_{22} \right)$

$R_{of} = \dfrac{A}{1+A\beta}$

$R_{if} = \infty$ #

R_{22} & R_{11} & β مفاضل ايجاد

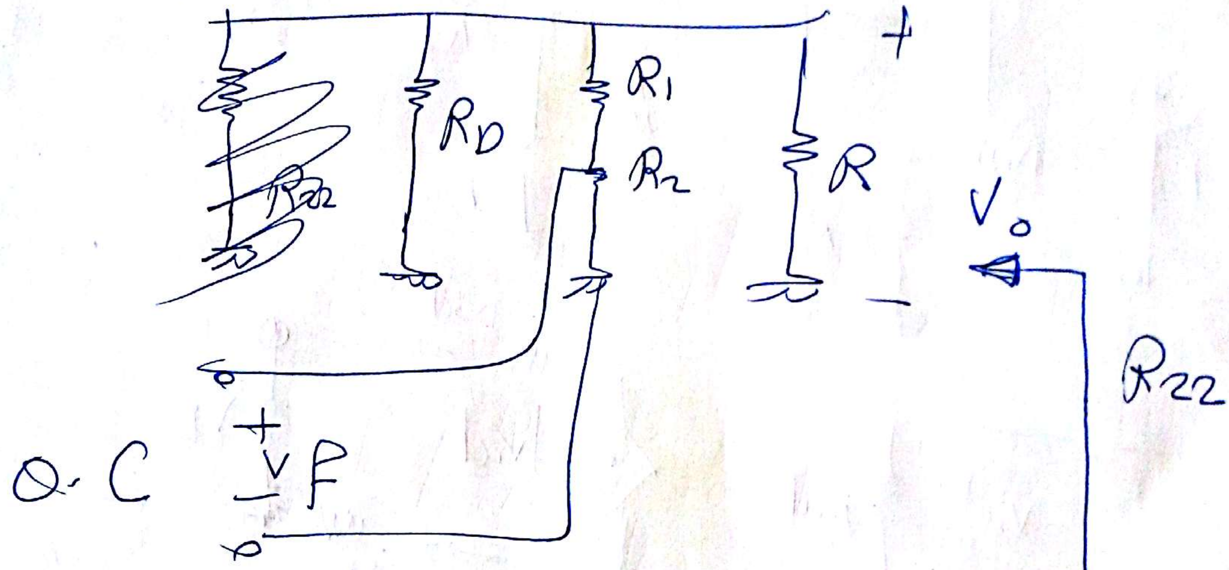
$\beta = \dfrac{V_f}{V_o} = \dfrac{R_2}{R_1+R_2}$ #



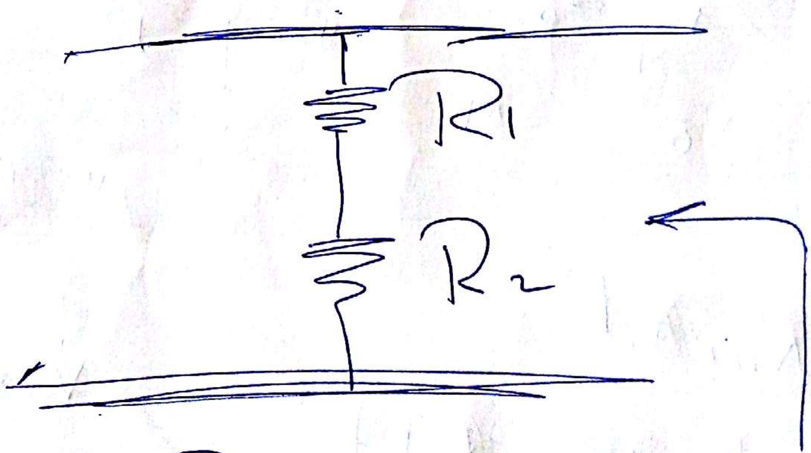
$V_f = V_o \times \dfrac{R_2}{R_1+R_2}$

R'_{22}

الفرع ده



$$R_{22} = R \parallel R_1 + R_2 \parallel R_D$$



$$R_{22} = R_1 + R_2$$